

REMARKS

Claims 1, 3–5, 7–6, and 11–16 will be pending; claims 3–5 and 11–13 have been withdrawn in response to a restriction requirement, and claims 2, 9, and 10 are cancelled. Claim 15 is rewritten in independent form, and claim 14 is amended to depend on claim 15. Claims 1 and 15 are now further amended to explicitly recite that the optical buffer layer confines light in the modified barium titanate thin film. Support for these amendments may be found, for example, on page 5, lines 7–10 and 14–17 of the specification and in the originally filed claims. No new matter has been added.

Rejection of claims under 35 U.S.C. § 112

Claim 7 is rejected under 35 U.S.C. § 112, second paragraph. Applicants submit this rejection is moot, in view of the amendment of claim 7 to depend on claim 1 rather than on cancelled claim 6.

Rejection of Claims Under 35 U.S.C. 103(a)

The Examiner has improperly rejected independent claims 1 and 9 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,198,269 to Swartz et al. (“Swartz”) in view of Rehrig et al., “Piezoelectric properties of zirconium-doped barium titanate single crystals grown by templated grain growth,” *Journal of Applied Physics*, Vol. 86, No. 2, August 1, 1999, pages 1657–1661 (“Rehrig”). The rejection of claim 9 is moot in view of the cancellation of that claim.

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The Examiner appears to consider the first sol-gel perovskite layer of Swartz to be an optical buffer layer, equivalent to the optical buffer layer recited in claim 1. The first sol-gel

perovskite layer disclosed by Swartz, however, is not an optical buffer layer. It is provided to enable the formation of a second perovskite layer with better crystallinity, and which crystallizes at a lower temperature and/or with shorter times. Indeed, given their high indices of refraction, the recommended layers “selected to produce [upon heat treatment] a perovskite of: lead titanate ($PbTiO_3$), or strontium titanate ($SrTiO_3$)” would not serve as optical buffer layers, i.e., would not confine an optical signal within modified barium titanate, as recited in amended claim 1. *See* column 3, line 41 – column 4, line 7.

The Examiner correctly states that buffer layer are commonly grown on substrates to enable better formation of additional layers thereon. The buffer layer recited in amended claim 1, however, is actually an optical buffer layer that has an index of refraction lower than that of the modified barium titanate, and that is suitable for confining an optical signal in the modified barium titanate thin film. Such optical buffer layers are not taught or suggested by the cited prior art.

The Examiner concedes that Swartz does not disclose modified barium titanate comprising 2 to 20 mol% of Zr ($BaZrO_3$), as recited in independent claim 1, and relies on Rehrig to teach thin films including these compositions. Rehrig, however, does not teach or suggest the formation of thin films including modified barium titanate. Rather, Rehrig discloses the formation of single crystals. One of skill in the art would find no motivation in the cited references to substitute the barium titanate thin film of Swartz formed from a sol-gel precursor with the single crystal of Rehrig formed by templated grain growth. The single crystal grown by Rehrig is not compatible with the sol-gel process of Swartz used for the formation of thin films. Moreover, even if one were to somehow combine the barium titanate single crystal of Rehrig with the structure of Swartz, one still would not obtain the modified barium titanate thin film recited in amended independent claims 1 and 9. Rather, one would have a modified barium titanate single crystal disposed on a substrate, and not a thin film.

The Examiner stresses that Rehrig is relied on only to teach a particular composition of barium titanate doped with zirconium. Rehrig discloses this composition as having desirable piezoelectric properties. *See* page 1657, first column, first and second paragraphs. Rehrig is

silent regarding the optical properties of this material. Moreover, Swartz suggests only barium titanate or barium strontium titanate for use in optical waveguide devices. *See* column 19, lines 53–55. The Swartz reference clearly does not contemplate the use of barium titanate comprising zirconium for optical waveguides: this material is mentioned in the reference, but only in connection with sensor applications. *See* column 20, lines 18-21. This material is not included with the list of materials deemed suitable for use in an optical waveguide. Swartz, thus, implicitly teaches away from the use of barium titanate doped with zirconium for optical waveguide devices. One of skill in the art would find no motivation in the cited references to modify Swartz's material by substituting the Zr-doped barium titanate material of Rehrig to obtain the optical structure recited in amended independent claim 1.

To summarize, a point of novelty of the claimed invention is the use of modified barium titanate containing zirconium in an optical structure. Swartz does not disclose such material for use in optical devices, and the Examiner has not provided any teaching or reference that would motivate one of skill in the art to modify Swartz so as to obtain the claimed invention. Indeed, even if the cited references were combined as the Examiner proposes, they *still would not teach or suggest* the requirements of claim 1: neither of the references teaches or suggests an optical buffer layer, nor do the references teach or suggest a barium zirconium titanate layer in combination with an optical buffer layer. The Examiner's rejection fails to satisfy the requirements of 35 U.S.C. § 103 because Swartz and Rehrig, alone or in combination, do not disclose every element of the invention as claimed.

Applicants submit that for at least these reasons, amended claim 1 and claims dependent therefrom are patentable.

Claims 1, 7–9, and 14–16 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,103,008 to McKee et al. (“McKee”) in view of Rehrig. The rejection of claim 9 is moot in view of the cancellation of that claim.

McKee appears to disclose a structure including a thin film of the perovskite BaTiO_3 , as well as the formation of such structure. In some embodiments, Zr or Hf may be substituted on the A site for barium in ABO_3 material. *See* column 2, line 59 – column 3, line 3. McKee does not teach or suggest a structure including barium titanate in which Ti is substituted with Zr on the B site, i.e., modified barium titanate comprising barium titanate including 2 to 20 mol% of Zr (BaZrO_3), as recited in amended independent claim 1, nor forming such structure, as recited in amended independent claim 15. Substituting Zr (a 4^+ ion) on the A site (for a 2^+ ion) would result in a material having significantly different properties from a material in which Zr is substituted on the B site (for a 4^+ ion). In the former case, Zr acts as a donor; in the latter case, the substitution is iso-valent and therefore charge-neutral.

McKee does not even appear to explicitly disclose BaTiO_3 in combination with ZrTiO_3 . Rather, he states "...Zr or Hf can provide the element A in alternative forms of ABO_3 material capable of being epitaxially grown ... in accordance with ... the present invention." *See* column 2, line 64 – column 3, line 3. McKee does not teach or suggest modified barium titanate comprising BaZrO_3 .

The Examiner asserts that the instant claims do not recite barium titanate in which Ti is substituted with Zr on the B site. Applicants respectfully disagree. Independent claims 1 and 15 recite modified barium titanate including $\text{Zr}(\text{BaZrO}_3)$. " BaZrO_3 " is the symbol for an ABO_3 material in which Ba is on the A site and Zr is on the B site (rather than on the A site, as taught by McKee). McKee appears to disclose BaTiO_3 , ZrTiO_3 , and HfTiO_3 . Moreover, the only dopant of ABO_3 material that McKee appears to disclose is Er. *See* claim 15 of McKee. McKee simply does not teach modified barium titanate including BaZrO_3 .

The Examiner concedes that McKee does not disclose modified barium titanate comprising 2 to 20 mol% of Zr (BaZrO_3), as recited in claims 1 and 15, and relies on Rehrig to teach thin films including these compositions. Rehrig does not teach or suggest the formation of thin films including modified barium titanate. Rather, Rehrig discloses the formation of single crystals. *See* abstract and page 1657, first column, first paragraph and second column, second paragraph. One of skill in the art would find no motivation in the cited references to substitute

the barium titanate thin film of McKee intended for electro-optical applications with the single crystal of Rehrig intended for sensor and actuator applications. The teachings of these two references are not combinable because the formation of bulk single crystals by templated grain growth, as taught by Rehrig, is inconsistent with the formation of thin films on semiconductor substrates by, e.g., epitaxy, as taught by McKee. Moreover, even if one were to somehow combine the barium titanate single crystal of Rehrig with the structure of McKee, one still would not obtain the modified barium titanate thin film recited in amended independent claims 1 and 15. Rather, one would have a modified barium titanate single crystal disposed on a substrate, and not a thin film. Neither reference, alone or in combination, teaches a modified barium titanate thin film comprising barium titanate including 2 to 20 mol% of Zr(BaZrO₃).

The Examiner stresses that Rehrig is relied on only to teach a particular composition of barium titanate doped with zirconium. Rehrig discloses this composition as having desirable piezoelectric properties. *See* page 1657, second column, first and second paragraphs. Rehrig is silent regarding the optical properties of this material. One of skill in the art would find no motivation in the cited art to substitute the Zr-doped barium titanate material of Rehrig for the material suggested by McKee for the formation of electro-optic devices, to obtain the optical structure recited in independent claim 1 or to form such structure as recited in independent claim 15.

Applicants submit that for at least these reasons, amended claims 1 and 15 and claims dependent therefrom are patentable.

In summary, Applicants do not claim to have invented the stabilization of barium titanate by the use of zirconium. Applicants, however, have made the surprising discovery that modified barium titanate including zirconium (BaZrO₃) is useful in optical devices. *See* specification, page 4, lines 1 – 7. The cited prior art, either alone or in combination, does not teach or suggest the optical device recited in amended independent claim 1, or a method for making such device, as recited in amended independent claim 15. More particularly, none of the cited references

teaches or suggests the use in optical devices of modified barium titanate that includes BaZrO₃, as claimed.

CONCLUSION

In light of the foregoing, Applicants respectfully submit that all claims are now in condition for allowance.

If the Examiner believes that a telephone conversation with Applicants' attorney would expedite allowance of this application, the Examiner is cordially invited to call the undersigned attorney at (617) 570-1806.

Applicants believe that no fee is due for filing of this amendment. However, if any additional fee is due, please charge said fee occasioned by this paper to our Deposit Account No. 07-1700.

This Amendment and Response is being filed within two months of the filing of a Notice of Appeal on April 5, 2006. In accordance with MPEP § 1205.01 and 37 C.F.R. 1.136(a), Applicants believe no petition or fee for an extension of time is needed. If however, a petition for an extension of time is needed for the entry of this Amendment and Response, please consider this to be a conditional petition for an extension of time, and permission to charge the appropriate fee to our Deposit Account No. 07-1700.

Respectfully submitted,

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